Pass-Through in Retail and Wholesale

Emi Nakamura
Columbia University

May 15, 2008

Motivation

- Retail prices are highly volatile, not very persistent
  - Standard deviation of weekly supermarket prices: 15%
- What explains these large price movements?
  - Shocks to marginal cost (Golosov and Lucas, 2007)
  - Demand shocks (Burstein and Hellwig, 2007)

Benchmark Menu Cost Model:

- Dixit-Stiglitz Demand
- Linear production function with idiosyncratic technology shocks

$$y_t(z) = A_t(z)L_t(z)$$

- Implies: Desired price is constant markup over marginal cost
- To change its price, the firm must hire K additional units of labor

Implications

Marginal costs/productivity have similar volatility to prices

Contrast vs. plant-level evidence on TFP

Annual survey of manufacturers: annual TFP volatility ≈ 0.10, persistence ≈ 0.7

Could reflect other cost components, demand shocks?

My Approach

- Shocks are hard to observe directly
- Indirect approach: Assess importance of demand/supply shocks by measuring the comovement of prices across products, firms and locations
- Manufacturer shocks: Cause prices to comove across stores for an identical item (e.g. 2L Diet Coke)
- Retail shocks: Cause prices to comove across items within a particular retail store (e.g. Soft Drinks at Dominick's)

Data

- AC Nielsen Storetrak
- Highly disaggregated store-level data
  - Weekly UPC-level data on prices and quantities
  - 7000 retail stores (33 major chains and 50 major cities)
  - 100 UPC's
  - 50 million observations
- Many more obs. per product than AC Nielsen Homescan, BLS
- Short time series: 52 weeks of data in 2004

Data (cont'd)

Categories and stores not random sample:

- Largest U.S. supermarket chains
- Not all stores agree to provide data to AC Nielsen (e.g. Walmart)
- Top 1-3 UPC's by national dollar sales volume in a wide variety of food categories
- Categories roughly correspond to food-at-home in U.S. CPI
- Categories: Beer, Bread, Cereal, Cheddar cheese, Crackers, Cream cheese, Canned soup, Coffee, Flour, Frankfurters, Ice cream, Apple juice, Margarine, Marinara, Oil, Peanut butter, Ravioli, Lime diet soft drinks, Cola, Diet cola, Lime soft drinks, Other soft drinks, Other diet soft drinks, Spaghetti, Sugar, Tuna

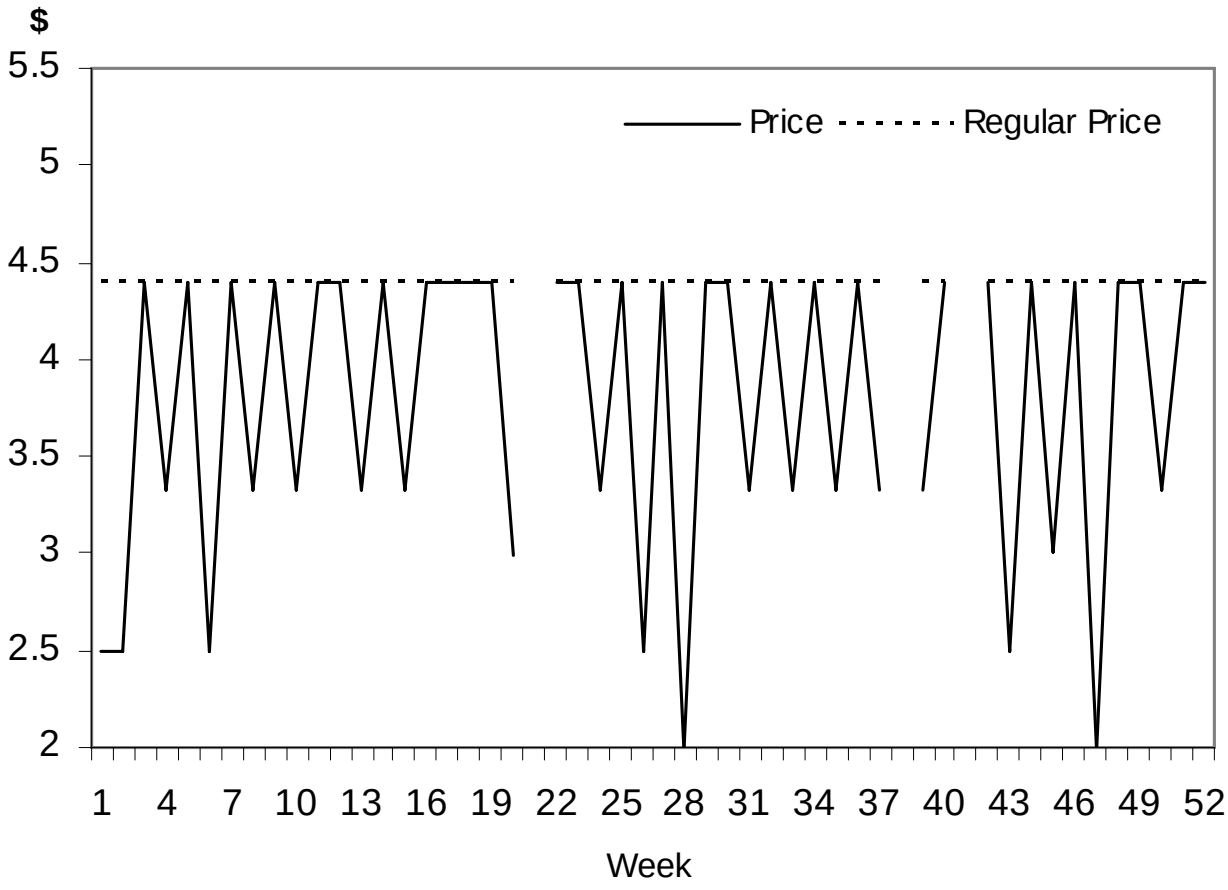
Outline

1. Basic facts about retail prices
2. Variance decomposition
3. Residual price movements and "temporary sales"
4. Interpretation:
   - Retailer vs. Manufactuer shocks?
   - Who adjusts prices?

Basic Facts about Retail Prices

1. Retail price series are highly volatile and close to serially uncorrelated
2. UPC-level averages are much less volatile and much more persistent
   - Average price of 2L Diet Coke across 7000 retail stores

Prices and Regular Prices



12 Pack of 12 Oz Diet Pepsi

Freq. of Price change and Standard Dev. (weekly data)

	All	Regular
Freq. (% per month)	43.9	19.0
Standard Dev.	15.3%	9.2%

Volatility of Prices

Indiv. Prices (weekly)	15.3%
Indiv. Prices (monthly)	9.5%
UPC Average	4.3%
Ratio Indiv. to UPC (monthly)	3.1

Dynamic Properties of Prices

Data	AR(1) Coef.
Raw	-0.04
Av. Monthly	0.19
Av. UPC Monthly	0.40

Variance Decomposition of Prices

- Estimate a random effects model that allows for category, chain, store and product effects
  - Components are normal, i.i.d.
  - Estimate by maximum likelihood
  - Focus on changes over time in prices (not level differences)
  - Use prices averaged over a month for a particular UPC/store (allow for correlations across diff. weeks within months)

Random Effects Model

Category (e.g. Soft Drinks)

- All stores (in City)
- Chain (e.g. Safeway)
- Indiv. store (e.g. Safeway @ 125 street)

UPC (e.g. 2L Diet Coke)

- All stores
- Chain
- Indiv. store

Interpretation

Manufacturer vs. retailer shocks

Recall:

- Manufacturer shocks: Cause prices to comove across stores for an identical item (e.g. 2L Diet Coke)
- Retail shocks: Cause prices to comove across items within a particular retail store (e.g. Soft Drinks at Dominicks)

Variance Decomposition: Estimation

- Separate variance decomposition within each city and product category
- Reducing the sample size:
  - Restricted sub-sample: top 10 stores (if 10 exist) within a particular retail chain and city, and the top twenty cities by sales over all product categories
- Present average variance components across stores and products

Variance Decomposition of Prices

Category-Level	All Stores	7.1
	Chain	9.8
	Indiv.	2.1
UPC-Level	All Stores	9.4
	Chain	55.0
	Indiv.	16.6

Variance Decomposition: Manufacturer vs. Retailer shocks

- 16% common to all stores selling an identical product.
- 65% common to stores within a particular retail chain.
- 17% completely idiosyncratic to the store and product.

TABLE A1
Variance Decomposition of Prices: Category Detail

	Category-Level			UPC-Level		
	All Stores	Chain	Indiv..	All Stores	Chain	Indiv.
Beer	5.5	4.7	0.3	24.1	50.8	14.6
Bread	6.5	2.3	2.3	12.8	70.8	5.3
Cereal	3.6	12.1	1.1	7.5	64.8	11.0
Cheddar cheese	4.1	1.8	0.6	15.9	66.7	10.8
Crackers	15.2	2.2	0.8	11.5	58.4	11.9
Cream cheese	38.1	38.5	7.7	0.5	9.1	6.1
Canned soup	13.1	10.8	1.7	8.4	55.1	10.9
Coffee	1.8	5.7	0.7	9.4	59.4	23.0
Flour	32.7	19.2	0.9	6.5	34.2	6.5
Frankfurters	1.3	2.3	1.3	7.5	64.2	23.4
Ice cream	0.7	8.6	6.5	6.0	56.3	21.8
Apple juice	0.1	0.0	2.2	11.4	73.7	12.7
Margarine	1.6	8.4	1.2	12.5	66.7	9.6
Marinara	3.2	0.8	0.3	10.8	72.6	12.2
Oil	3.4	3.8	0.8	8.4	66.1	17.4
Peanut butter	2.3	1.1	0.9	8.9	70.1	16.7
Ravioli	18.8	68.6	6.3	0.1	0.7	5.5
Soft drinks lime diet	1.3	3.3	1.3	8.2	50.7	35.2
Soft drinks cola	3.3	0.8	1.3	8.1	54.2	32.3
Soft drinks cola diet	3.4	3.3	1.6	10.4	52.6	28.8
Soft drinks lime	1.6	3.2	0.9	7.6	58.2	28.5
Soft drinks other	5.8	20.3	5.6	5.0	41.2	22.1
Soft drinks other diet	5.4	12.2	5.8	3.5	39.8	33.4
Spaghetti	4.7	11.2	0.6	3.3	66.8	13.3
Sugar	5.1	8.7	2.1	28.2	47.3	8.7
Tuna	1.1	1.8	0.4	7.3	79.0	10.4
Weighted Mean	7.1	9.8	2.1	9.4	55.0	16.6

Retail Shocks

- 82% of price fluctuations
- Is this plausible?

Cost-based explanations:

  - Supermarket gross margins approx. 30%
  - Requires extremely large retail cost shocks

Retail Shocks (cont'd)

Demand-based explanations

- Small fraction of price variation (19%) is common to all UPC's in a category at a store (e.g. soft drinks)
- Implies: Most retail demand shocks must be idiosyncratic to a particular UPC at a particular retail chain
- Dynamic pricing strategies?

Variance Decomposition of Prices

Category-Level	All Stores	7.1
	Chain	9.8
	Indiv.	2.1
UPC-Level	All Stores	9.4
	Chain	55.0
	Indiv.	16.6

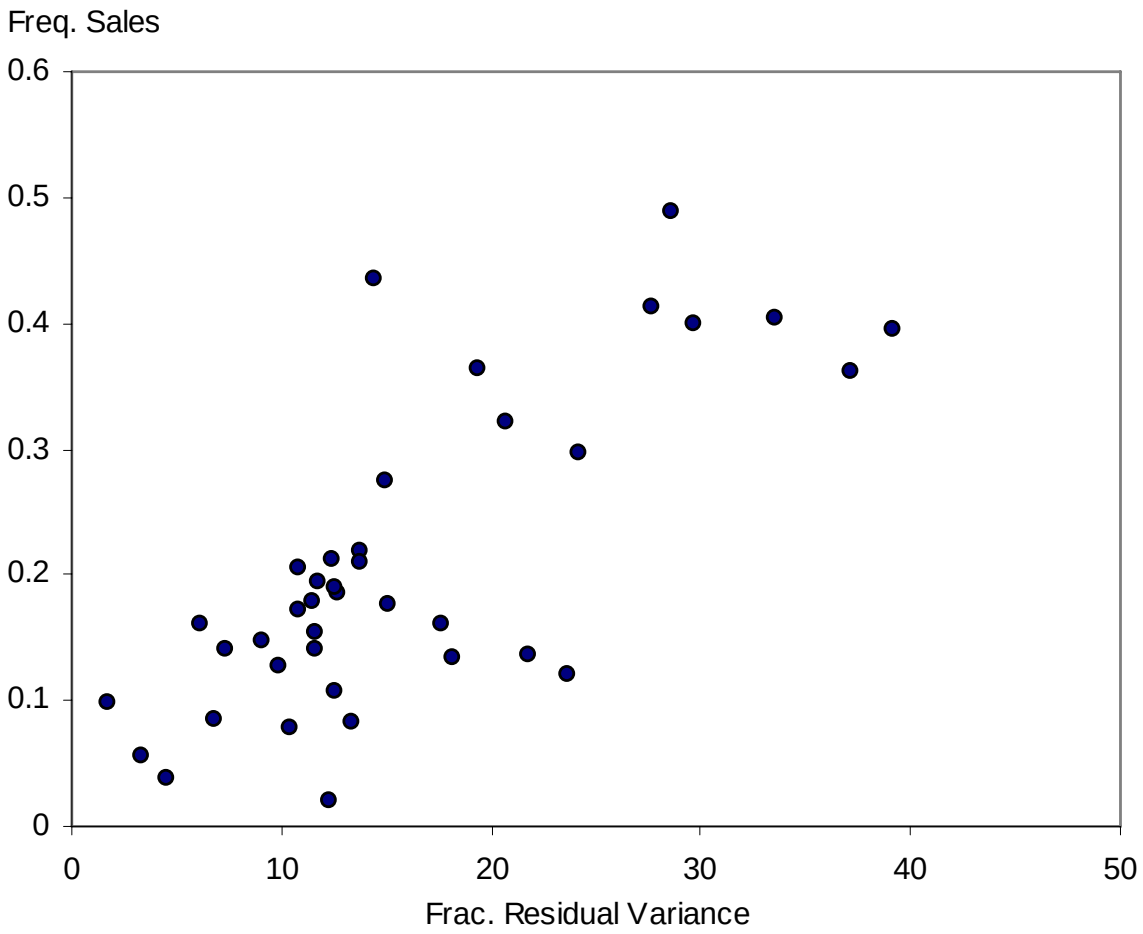
Dynamic pricing theories

- Price Discrimination at the retail level (Varian, 1980)
- Inventory Management (Lazear, 1986)
  - Due to unpredictable shifts in taste (fashion)
  - Due to changes in aggregate demand

Residual Price Movements and "Temporary Sales"

- Most theories of "temporary sales" rely on dynamic pricing strategies
- Is there a relationship between temporary sales and the "residual" price variation?

Sales vs. Residual Variance



Who Adjusts Prices?

Two potential explanations for evidence on comovement:

1. Retailer adds a substantial amount of "noise" to common manufacturer prices (as in e.g. dynamic theories of sales)
2. Manufacturer price discrimination

Need manufacturer price data to answer this question

Legal barriers to price discrimination?

Complexities with Manufacturer Prices

- Trade Deals: complex "performance based" contracts
- Manufacturers often offer retailers a menu of trade deals with different requirement, which may be taken up at diff. times
- In 49.8% of cases the retailer initiates the trade promotion and in 58.9% of cases the retailer selects the trade promotion type (Maratou, 2006)
- These factors make wholesale prices substantially more difficult to interpret than retail prices.

ANNOUNCING A KELLOGG'S/
SCANNER APPLICATIONS PROMOTION:
BUY TWO 12CT POP TARTS, GET $2.00 OFF MILK ½ GALLON OR GALLON.
ANY TWO WEEKS BETWEEN JUNE 1 AND JULY 26, 2008

(Two-week Program): Choose any two weeks between June 1 and July 26, 2008

Product Promoted	Unit UPC # 38000-	Promotion Offer
Pop Tarts 12ct:		
Indiana Jones	02334	**Buy 2, Get $2.00 off milk ½ gallon or gallon**
Frosted Hot Fudge Sundae	29697	**Buy 2, Get $2.00 off milk ½ gallon or gallon**
Strawberry	30420	**Buy 2, Get $2.00 off milk ½ gallon or gallon**
Frosted Blueberry	31020	**Buy 2, Get $2.00 off milk ½ gallon or gallon**
Frosted Brown Sugar Cinnamon	31120	**Buy 2, Get $2.00 off milk ½ gallon or gallon**
Frosted Chocolate Fudge	31320	**Buy 2, Get $2.00 off milk ½ gallon or gallon**
Frosted Strawberry	31720	**Buy 2, Get $2.00 off milk ½ gallon or gallon**
Frosted Cherry	31820	**Buy 2, Get $2.00 off milk ½ gallon or gallon**
Knock Knock Jokes Printed Fun Strawberry	31905	**Buy 2, Get $2.00 off milk ½ gallon or gallon**
Frosted S'mores	32120	**Buy 2, Get $2.00 off milk ½ gallon or gallon**
Chocolate Chip	59660	**Buy 2, Get $2.00 off milk ½ gallon or gallon**

SUMMARY: This Buy two Kellogg's 12 count Pop Tarts, Get $2.00 off milk ½ Gallon or Gallon, program is available for any two weeks, consecutive or non-consecutive, between June 1 and July 26, 2008.

NO REIMBURSEMENT WILL BE MADE ON ITEMS DISCOUNTED INDIVIDUALLY.

Evidence on Trade deals

- Manufacturer trade deals allow for substantial flexibility in how trade deals are implemented by retailers
- Retailers can choose the timing of promotion within window
- Most trade deals require that retailers promote (reduce price below the "regular" price)
- Retailers prefer to stagger the timing of promotions across both *products* and *retail chains*

Conclusions

- Monthly UPC-level averages across 7000 retail stores $< 1/3$ as variable as individual prices
- Variance decomposition:
  - 16% of price variation is common across all stores
  - 65% common to stores within a retail chain
  - 17% completely idiosyncratic to the store and product
- Of chain-level variation, only 19% is common to all UPC's in the product category
- Purely idiosyncratic price changes happen more often in sectors with many "temporary sales"

Macro implications

Demand and supply shocks may be much smaller than observed variability in retail prices

Dynamics of wholesale prices may differ substantially from dynamics of retail prices

Implications for:

- Relative magnitude of aggregate vs. idiosyncratic shocks
- Real rigidities